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Description

The present invention relates to a method for controlling transmission power in radio communication between a mobile station and a base station of a digital mobile radio system.

BACKGROUND ART

A cellular mobile radio system may comprise a plurality of cells. Each cell has at least one base station for simultaneous communication with a number of mobile stations. Signal transmission is effected between the base station of a cell and the mobile stations served by the base station in said cell by transmitting and receiving radio signals, for instance when the mobile stations are used for calling purposes.

It is known to have a so-called fixed frequency plan in mobile radio systems which utilize FDMA and/or TDMA in order to obtain a large number of radio communication channels, i.e. signals are transmitted in each cell between the base station and the mobile stations on a given number of determined radio frequencies. For instance, a cell can be assigned twenty different signal transmission frequencies. The cells are divided logically into groups, with several cells in each group. The cells within one group utilize different radio frequencies, although cells in different groups may utilize the same radio frequencies.

An alternative to a fixed frequency plan for FDMA and TDMA is the so-called adaptive or dynamic assignment of channels/frequencies. All, or at least some, of the available radio frequencies and, in the case of TDMA, also the time slots on the radio frequencies, constitute a common resource for all, or at least several neighbouring cells. One example of dynamic channel assignment is described in U.S. 4,736,453.

An alternative to FDMA and TDMA when desiring a large number of radio communication channels is CDMA, Code Division Multiple Access. In a mobile radio system in which CDMA is applied and in which traffic is not unduly excessive, it is conceivable to use only a single radio frequency, or rather a single radio frequency band. This radio band has no fixed division of separate time slots which are allocated to separate stations, but instead the whole radio band can be used simultaneously in different ways by all of the mobile stations. An example of CDMA is described in EP 0189695.

Power regulation in mobile radio systems with analogue information transmission is of a relatively simple kind and the adjustment is a relatively rough adjustment. See in this respect U.S. Patent Specification No. 4,485,486. According to one proposed standard for digital mobile radio systems, for example GSM in Europe and EIA/TIA IS-54 in the U.S.A., protocol is found for the transmission of measurement information and commands concerning transmission power.

The US patent 4,811,421 discloses a method for regulating the transmitted power of radiosignals transmitted with signal transmission between a mobile station and a base station in a digital mobile radio system. The method includes the steps of measuring the power of a signal received by the station at predetermined instants; estimating, as a function of the measured power, at each predetermined instant a signal power which will be received by the station at a following predetermined instant, and controlling a signal power transmitted by the station between the successive instants in proportion to the estimated power.

The patent US 4,777,653 relates to an apparatus for controlling the transmission power of a transmitting station over a digital radio communication channel, based on information relating to the level of the signal received at a receiving station and information relating to the quality of such received signal. The signal level information and signal quality information is derived by respective threshold measurement devices in the receiving station, and is transmitted back to the transmitting station over a return channel. The transmitting station comprises means for effecting combined processing of such information to derive a control signal which controls means for increasing or decreasing the transmitting power over a dynamic adjustment range.

DISCLOSURE OF THE INVENTION

As will be understood, in a mobile telephony system in which the same radio frequency or frequencies is/are used for several connections, for instance telephone calls or data communication, in one of the aforedescribed manners, or possibly in some other manner, there is a risk that a connection will be subjected to excessively large disturbances from other connections, since the radio signals that are transmitted simultaneously, at least in part, on the same frequency or frequencies can interfere with one another to an excessive extent. Depending on whether a system has a fixed frequency plan or dynamic channel assignment, and also on whether the system utilizes FDMA or TDMA or CDMA, interference can occur either between communication channels in one and the same cell or in different cells, these channels using the same radio frequency and/or when applicable the same time slot for the transmission of information. The risk of excessive disturbance is particularly high when the transmission powers of transmitted radio signals are not mutually adapted. This lack of adaptation can occur either within the confines of the cells themselves or between the cells, i.e. so that the transmission powers in one cell are excessively high in relation to the powers in another cell. When the disturbances on an established connection, for example a

telephone call or data communication, become so excessive that transmitted information, speech or data cannot be interpreted or decoded in the receiver, the connection is broken. It is desirable to maintain the transmission power of disturbance signals as low as possible, so as to avoid these disturbance problems.

Another reason for maintaining the transmission power at the lowest possible level is because this will enable the energy consumption of mobile stations to be reduced, therewith enabling the batteries used to power portable mobile stations to have a smaller capacity and therewith to be less bulky, so as to enable portable mobile stations to be made smaller.

However, it is not possible to transmit signals of excessively low power, since there is then the risk that the information contained in the signals cannot be interpreted or decoded in the receiver, because the signals are too weak upon reception, therewith causing an established connection to be broken, as previously mentioned.

Accordingly, the object of the present invention is to solve the aforesaid problem by regulating the transmission power of a mobile station or a base station in a manner to maintain said power at the lowest possible level, so as not to create said disturbance problem unnecessarily while, at the same time, maintaining the transmission power constantly at a sufficiently high level for the transmitted information to reach the receiver and to be interpreted or decoded therein.

Thus, the invention relates to a method for regulating the transmission power of a mobile station or a base station in a manner such that said power will be constantly maintained at an optimum. In brief, the method involves collecting measurement values of signal strength and signal transmission quality over two mutually adjacent time periods from the present or instant time-point and backwards. The mean values of signal strength and of signal transmission quality are calculated and estimated on the basis of these measurement values. An anticipated value of the signal level and of the quality of the signal transmission at the next point in time are calculated with the aid of the aforesaid calculated mean values, while taking into account the environment in which the mobile station is located, provided that the transmission power is maintained unchanged in relation to the power transmitted at the present point in time. The transmission power is regulated finally with the aid of said anticipated values of transmission quality and signal level, wherein the power transmitted at the next point in time is increased when the anticipated transmission quality is poorer than that desired, and is decreased when the anticipated value of transmission quality is higher than the highest permitted quality or when the anticipated value of the signal strength is greater than the maximum permitted value, said transmission power otherwise being maintained unchanged.

Since power control is effected on the basis of what can be expected to happen to the signal level and to the quality of signal transmission at the next, future point in time if the power output is maintained constant in comparison with the present point in time, the power transmitted can often be controlled or regulated in phase with the need for a change in the power output. Transmission power may, for instance, often be increased at the same time as the need for higher power occurs, since the need is anticipated. Consequently, transmission power can often be maintained continuously at an optimal level, i.e. at the lowest possible level but, nevertheless, sufficiently high for the transmitted information to be interpreted in the receiver. The actual adjustment of the transmission power is computer controlled and can be based on a few relatively simple conditions, therefore enabling the power adjustment time to be kept short, which is necessary if the power is to be regulated in phase with the need for such regulation.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a cell-divided mobile radio system;
Figure 2 is a block schematic of a mobile station;
Figure 3 is a block schematic of a base station;
Figure 4 is a flow sheet illustrating power control; and
Figure 5 is a diagramme of measurement data collected over two mutually sequential time periods.

BEST MODE OF CARRYING OUT THE INVENTION

Figure 1 illustrates ten cells, C1 to C10, included in a cellular mobile radio system. Each cell C1 to C10 has a base station B1 to B10, with the same number as the cell. The system illustrated in Figure 1 also includes ten mobile stations M1 to M10 which are movable within a single cell and also from one cell to another. The invention is applied normally in a cellular mobile system which includes far more than ten cells/base stations and ten mobile stations. More specifically, there are normally many more mobile stations than base stations.

The system illustrated in Figure 1 also includes a mobile radio telephone exchange MSC which is connected to all of the illustrated ten base stations by means of cables. The mobile radio exchange may also be cable-connected to a stationary, public telephone network or to a stationary private telephone network. Not all of the cables from the exchange are shown in the Figure.

The mobile system illustrated in Figure 1 includes at least one duplex radio channel (two simplex channels) which is common to all base stations and mobile

stations. The radio channel may be divided into time slots. No radio channel or time slot is reserved exclusively for solely one particular base station or one particular mobile station. The radio channel/radio channels/time slots are instead a common resource for use by base stations and mobile stations in accordance with requirements and with prevailing traffic. In some cases, the mobile radio exchange may take any decisions necessary with respect to the radio frequency and the time slot on which a mobile station shall transmit when a number of alternatives are available.

Numerous digital cellular mobile radio systems have been proposed in the art and consequently the person skilled in this art does not require a detailed description of how such a system operates, for instance the system illustrated in Figure 1, in order to apply the invention. For the sake of completeness, it is recommended that the person who is not skilled in this art should study specifications and specification drafts for the GSM and EIA/TIA IS-54 systems for information on digital mobile radio systems which use TDMA. Several base stations and mobile stations for digital cell-divided mobile radio systems have been proposed in the art, and consequently it is not thought necessary to describe such stations in detail in order for the person skilled in this art to be able to practice the invention. For the sake of simplicity and with consideration to the person not skilled in this art, Figures 2 and 3 of the present specification illustrate conceivable block schematics for a base station and a mobile station respectively for use in a system illustrated in Figure 1. The illustrated base and mobile stations are constructed for communication with one another in accordance with EIA/TIA, Cellular System, Dual-Mode Mobile Station-Base Station Compatibility Standard, IS-54.

The present invention relates to a method for controlling or regulating the power of transmitted signals when transmitting signals between a mobile station and a base station, for instance according to Figures 2 and 3, in a cell-divided digital mobile radio system, for instance according to Figure 1, so as to maintain the power level constantly at an optimum. The power level is optimal when it is as low as possible, so as not to disturb unnecessarily other channels which use the same frequency for signal transmission, at least partially simultaneously, but, nevertheless, sufficiently high for the information transmitted to reach the receiver. Described in the following is an exemplifying embodiment of a method in which the power of the signal transmitted from the mobile station is regulated by calculations and commands from the controlling base station.

The transmission power is regulated with the aid of a computer which is controlled externally by two measurable magnitudes, namely signal level and signal transmission quality. These magnitudes are measured in the receiver, which in the illustrated case is the base station. Signal levels may be measured by sampling in a known manner, for example once per half-second.

The quality of the signal transmission is measured by estimating, or measuring, bit error content/bit error rate on the communication concerned. For example, in the case of a digital mobile radio system of GSM or TIA type, or a similar type, the signal quality can be measured by assessing the error rate/error content of the digital symbols (normally the number of bits which are in error in relation to the total number of bits) in a manner similar to the manner proposed in a contribution from Italtel within the framework of the work carried on the GSM system and described in a GSM document entitled GSM/WP2 Doc. 17/88. Based on the method proposed by Italtel, Ericsson proposed in a contribution to TIA, Technical Subcommittee, TR-45 Digital Cellular Standards, meeting on August 29, 1989, in San Diego, California, a method of measuring and transmitting information relating to bit error rate in a digital cellular system according to EIA/TIA intended for the U.S.A.

Measurement data is stored continuously in the computer, for use with so-called mean value formation. (See Square 1 in the flow chart). Two mean values of signal level and signal quality respectively are formed from the collected measurement data. (Square 2 in the flow chart). A diagramme of the collected measurement data is given in Figure 5. The horizontal axes show time t. The vertical axis of the upper diagramme shows signal level SS, unit decibel dB, whereas the vertical axis of the bottom diagramme shows quality QQ, measured in (relative) the number of bit errors in a received signal. A first mean value of respective magnitudes is formed from measurement data collected during a first time period A1 from and including the present time-point to and backwards. Another mean value of respective magnitudes is formed from measurement data collected during a second time period A2 which is the nearest preceding time period to the first mentioned time period A1. Thus, according to the present example, a first signal-level mean value MV_1_SS is formed from four different sets of measurement data obtained at the time-points t_{-3}, t_{-2}, t_{-1}, t_{-0}. A first quality mean-value MV_1_QQ is formed from measurement data obtained at the same time-points. Thus, according to the illustrated example, a second signal-level mean value MV_2_SS is formed from six different sets of measurement data obtained at the time-points t_{-9}, t_{-8}, t_{-7}, t_{-6}, t_{-5}, t_{-4}, and, finally a second quality mean-value MV_2_QQ is also formed from the measurement data obtained at these time-points.

On the basis of these calculated mean values of the signal level, there is calculated an anticipated value Z_SS of the signal level at the next time-point t_1 one-half second forward in time, provided that the

power of the transmitted signal is unchanged in comparison with the power transmitted at the present or instant time-point t_0 (Square 3 in the flow sheet). This calculation is effected while taking into account the environment in which the base station and the mobile station are located, which is achieved with the aid of a signal environment factor SS_K. According to the illustrated example, the anticipated value Z_SS of the signal level is calculated in the following manner:

Z_SS = MV_2_SS + SS_K∗ (MV_1_SS - MV_2_SS)

An anticipated value Z_QQ of the quality of the signal transmission at the next time-point t_1 is calculated in a corresponding manner, with the assumption that the power of the signal transmitted is unchanged from the present time-point t_0. Similar to the calculation of anticipated signal level Z_SS, attention is also paid to the environment in which the mobile and the base station are located, with the aid of a quality environment factor QQ_K. Thus, the anticipated quality value Z_QQ is calculated in the following manner:

Z_QQ = MV_2_QQ + QQ_K∗ (MV_1_QQ_MV_2_QQ)

As will be evident from the above formulae, the two calculations of the anticipated values are carried out according to one and the same pattern. As before mentioned, the environment factor, SS_K and QQ_K respectively, which are multiplied with the difference between the first and the second mean value, are assigned a value which is contingent on the environment in which the mobile station and the base station are located. The value depends on the nature of the environment in the cell of the base station. For example, when the cell includes a town or city environment, so-called rapid trend detection is desired, since the conditions for radio-signal propagation can change very rapidly, for example when a car equipped with a mobile station turns a street corner. Rapid trend detection is obtained when said environment factors are assigned a relatively high value, for instance SS_K=2, QQ_K=2. On the other hand, when the cell embraces relatively flat landscape or countryside, so-called sluggish trend detection is desired, in which case the aforesaid environment factors are assigned a relatively low value, for example SS_K = 0.5, QQ_K = 0.5. Thus, the trend is given by the difference between the first and the second mean value and can be either amplified or weakened as desired in dependence on peripheral environment with the aid of the environment factors. The calculated or estimated trend, which thus corresponds to the difference between the first and the second mean value, multiplied by an environment factor, is added to the second mean value, therewith obtaining the aforesaid anticipated values of signal level and quality respectively. (Square 3 in the flow chart). The results obtained when calculating the anticipated values of signal level and quality are thus influenced by the values assigned to the two environment factors SS_K, QQ_K. The results can be further influenced, in a desired manner, by giving the various measurement values or samples different weights or significances in the mean value calculations. This is achieved by selecting the number of measurement values to be included in the first and the second mean value respectively, which corresponds to selecting the length of said two time periods, since the measurement values are sampled each half-second. The number of measurement values or samples in the first time period A1 are designated SS_A1 and the number of samples in the second time period A2 are designated SS_A2. When the measurement values in both time periods are of equal number, the weighting of both mean values is equally as great. When the number of measurement values in the first time period A1 is fewer than the number of measurement values in the second time period A2, the weighting of each measurement value in the first time period A1 is greater than in the second time period A2. On the other hand, if the number of measurement values in the first time period A1 is fewer than in the second time period A2, weighting of each measurement value in the second time period A2 is lower than in the first time period A1. In a city or town, where the environment in which the mobile station moves can vary very rapidly, it may be appropriate, for instance, to assign a high weighting to the latest measurement values, which is the case when the number of measurement values during the first time period A1 is fewer than during the second time period A2.

The anticipated signal-level and quality values Z_SS, Z_QQ, are used as input data for the actual power regulating process. When regulating transmission power, the input data is compared with certain parameters relating to signal level and quality respectively, these parameters being stored in the computer. In the case of signal level, there is found a first parameter SS_DES which denotes the desired value, and a second parameter SS_MAX which denotes the maximum signal-level value permitted. With respect to the quality of signal transmission, three different parameters are found, a first parameter QQ_MIN which denotes the least number of bit errors permitted (best permitted quality value), a second parameter, QQ_MAX which denotes the maximum number of bit errors permitted (worst permitted quality value) and finally a third parameter QQ_DES which denotes the desired quality value. These parameters are marked in the diagramme shown in Figure 5. In addition to the aforesaid anticipated values Z_SS, Z_QQ, the input data used to effect power regulation also includes the latest power output PREV_MS_PWR ordered to the mobile station, i.e. the power output at the present time-point t_0.

Thus, when regulating power on the basis of the aforesaid input data Z_SS, Z_QQ, PREV_MS_PWR, there is calculated a minimum power output which will

ensure connection quality. The calculated, new power output for the next time-point t_1 is designated MS_PWR. According to the illustrated example, the power output is regulated in the following manner. When testing a first condition 4, an expected quality Z_QQ is compared with the worst permitted quality-value QQ_MAX. If the anticipated quality Z_QQ is very poor, i.e. the anticipated number of bit errors in the transmission at the next time-point t_1 is fewer than the maximum number of permitted bit errors QQ_MAX, the power output is increased to the maximum permitted/possible power output of the mobile MAX_MS_PWR. (IF Z_QQ > QQ_MAX THEN MS_PWR = MAX_MS_PWR).

If the first condition 4 is not fulfilled a test is carried out on a second condition 5, which checks whether or not the anticipated quality Z_QQ is poorer than the desired quality, i.e. the anticipated number of bit errors during transmission is fewer than the number appropriate for the desired quality QQ_DES. If the second condition 5 is fulfilled, i.e. the anticipated quality Z_QQ is poorer than the desired quality, the power output is increased in a manner which gives the greatest increase in power output. The power output is either increased by 2 dB or is increased by the difference between the desired signal level SS_DES and the calculated anticipated signal level Z_SS. (IF Z_QQ > QQ_DES THEN MS_PWR = MAX (PREV_MS_PWR + 2, PREV_MS_PWR + SS_DES-Z_SS)).

If the second condition 5 is not fulfilled either, a third condition 6 is tested so as to ascertain whether or not the anticipated quality Z_QQ is better than the permitted quality or whether the anticipated signal level Z_SS is higher than the permitted signal level, and whether a given number of samples DES_INT have passed since the preceding power decrease. If the third condition 6 is fulfilled, the power output is lowered by 2 dB. (IF (Z_QQ < QQ_MIN OR Z_SS> SS_MAX) AND the number of samples since the preceding power decrease > DEC_INT THEN MS_PWR = PREV_MS_PWR -2dB).

If none of the aforesaid conditions 4, 5, 6 is fulfilled, this means that the anticipated signal level and signal quality are at the desired level, wherewith the latest ordered power output PREV_MS_PRW is also maintained at the next time-point t_1. The tests made on the aforesaid conditions can be summarized with the following, simplified programme lines, the bracketed numerals referring to the flow chart.

(4) IF Z_QQ > QQ_MAX THEN MS_PWR = MAX_MS_PWR

(5) IF Z_QQ > QQ_DES THEN MS_PWR = MAX (PREV_MS_PWR+2, PREV_MS_PWR+SS_DES-Z_SS)

(6) IF (Z_QQ < QQ_MIN OR Z_SS > SS_MAX) AND the number of samples prior to power decrease is then > DEC_INT, MS_PWR will then equal PREV_MS_PWR-2dB

(7) ELSE MS_PWR = PREV_MS_PWR

Thus, subsequent to carrying out the tests above, a new power output is calculated for signals that are to be transmitted from the mobile station to the base station, from and including the next time-point t_1. Before the new power output MS_PWR is ordered to the mobile station, a check is made to ascertain that the level of the new power output lies within permitted limits. This check is made, for instance, with the aid of a fourth and a fifth test 8, 9. The fifth test 8 ascertains whether or not the new power output MS_PWR is too low, which it is if the new power output is lower than a smallest level which corresponds to the maximum permitted/possible power output MAX_MS_PWR minus a maximum number of decibels MAX_DEC. If the test shows that the new output is too low, the power output is raised to the next lowest level. (IF MS_PWR < MAX_MS_PWR-MAX_DEC THEN MS_PWR = MAX_MS_PWR-MAX_DEC).

The sixth and the last test 9 ascertains whether or not the new power output is higher than the maximum permitted/possible power output. If so is the case, the new power output is changed to the maximum permitted/possible power output. (IF MS_PWR > MAX_MS_PWR THEN MS_PWR = MAX_MS_PWR).

If none of the two last conditions 8, 9 is fulfilled, the calculated new power output was thus within the permitted limits.

Finally, an order is sent to the mobile station to the effect that said station shall adjust the power output to the new calculated power output MS_PWR, which may possibly be the same as the present or instant power output PREV_MS_PWR. (Square 10 in the flow chart). In the aforesaid U.S. standard EIA/TIA, there is a format for orders concerning mobile station power mm and acknowledgement of received orders concerning mobile station power mm that can be utilized. The mobile station computer adjusts the power transmitted from the mobile station upon receiving an order that such adjustment shall take place, so that at the next time-point t_1 the mobile station will transmit signals with the new power output MS_PWR calculated in the aforedescribed manner.

At the next time-point t_1, one-half second after the present time-point t_0, the aforedescribed method is repeated so as to calculate the next power adjustment, although the time-point designations are moved forward one step on the time axis t in Figure 2, so that the time-point designated to again designates the"present" time-point.

Depending on the transmission time between base station and mobile station and as to whether power is regulated or adjusted in a base station or a mobile station, certain time differences may occur in practice between the time at which power adjustment is effected and the time at which an order to adjust said power is issued. Consequently, in some instanc-

es, the time-point t_2 in Figure 5 or any arbitrary time-point t > to can designate the next time-point with regard to the anticipated values Z_SS and Z_QQ and the new power output MS_PWR.

The invention can be applied within different types of systems, both within systems which apply FDMA and those which apply TDMA or CDMA. Irrespective of the system in which the invention is applied, it is, of course, important that the signals measured are transmitted by the correct station. When the method is applied with a mobile radio system of the FDMA-type, in which the transmission times on the radio frequencies are not divided into time slots but in which each connection can constantly use one radio frequency, it is, of course, possible to choose the time-points at which signal level and signal quality are measured comparitively freely without taking time slots into account. On the other hand, when the invention is applied in a mobile radio system of the TDMA-type, it is necessary to select the time-points within the correct time slot.

Other methods of defining and measuring the quality of an established communication channel than the methods described above are, of course, conceivable within the scope of the invention.

Base stations and mobile stations for digital mobile radio systems include processors and memories which can be used appropriately for processing and storing measurement values, the mean values and anticipated mean values in accordance with the invention. As will be understood, separate processors and memories can be used instead, when practicing the inventive method, if so desired. Which processors can be used appropriately for which stage of the inventive method will naturally depend on the extent to which the measurement values are collected, stored and processed in the base station or in the mobile station.

In the case of a mobile radio station constructed in accordance with the European standard GSM, this system including a "Base Station Controller" BSC for controlling several base stations, storage and processing of the measurement values may, instead, be effected in said "Base Station Controller" BSC. The actual measurements themselves are taken in either the base station or the mobile station, in the aforedescribed manner.

Claims

1. A method for regulating the power (MS_PWR) of radiosignals transmitted with signal transmission between a mobile station and a base station in a digital mobile radio system, wherein the power output (MS_PWR) is regulated continuously such that said power is sufficiently low not to disturb unnecessarily other signal transmissions where transmission takes place, at least timewise, on the same frequency, but sufficiently high for signal transmission to be effected without excessive loss of information due to excessively low signal/disturbance conditions, **characterized** by the steps of:
   - calculating a first signal-strength-mean value (MV_1_SS) of a radio signal transmission during a first time period (A1) from and including the present or instant time-point (t_0) and backwards;
   - calculating a second signal-strength-mean value (MV_2_SS) during a second time period (A2) immediately preceding said first time period (A1);
   - calculating a first quality mean-value (MV_1_QQ) of the signal transmission during said first time period (A1) and a second quality mean-value (MV_2_QQ) during said second time period (A2);
   - calculating an anticipated value (Z_SS) of the signal level of said signal transmission at the next time-point (t_1) based on said signal-strength mean values (MV_1_SS, MV_2_SS) and a transmission power (MS_PWR) that is unchanged in comparison with the transmission power (PREV_MS_PWR) at said present time-point (t_0);
   - calculating an anticipated value (Z_QQ) of the quality of the signal transmission at the next time-point (t_1) based on said quality mean values (MV_1_QQ, MV_2_QQ) and a transmission power (MS_PWR) that is unchanged in comparison with the transmission power (PREV_MS_PWR) at the present timepoint (t_0);
   - regulating the transmission power (MS_PWR) with the aid of said anticipated values (Z_SS, Z_QQ) of the transmission quality and signal level, wherein the transmission power (MS_PWR) at the next time point (t_1) is increased when the anticipated transmission quality (Z_QQ) is poorer than a desired value and is reduced when the anticipated quality (Z_QQ) is higher than the highest permitted quality or when the anticipated value (Z_SS) of the signal strength is greater than a maximum permitted value (SS_MAX), the transmission power (MS_PWR) otherwise being maintained unchanged.

2. A method according to Claim 1, **characterized** in that said mean value calculations are carried out by sampling the measurement values of signal strength (SS) and quality (QQ) respectively at constant time intervals, wherein said first time period (A1) includes a first number (SS_A1) of

samples and said second time period (A2) includes another number of samples (SS_A2).

3. A method according to Claim 2, **characterized** in that the first number of samples (SS_A1) taken during the later time period (A1) for said signal level and said quality respectively is smaller than the other number of samples (SS_A2), where-in the later samples are weighted more heavily than the earlier samples.

4. A method according to Claim 1, **characterized** in that when calculating said anticipated values (Z_SS) of the signal level, the second-strength mean-value (MV_2_SS) is added to the difference between the first (MV_1_SS) and the second (MV_2_SS) signal-strength mean value multiplied with an environment signal factor (SS_K), and in that when calculating the anticipated value (Z_QQ) of the signal transmission quality, the second quality mean-value (MV_2_QQ) is added to the difference between the first (MV_1_QQ) and the second (MV_2_QQ) quality mean-value multiplied by an environment quality factor (QQ_K).

5. A method according to Claim 1, **characterized** by increasing the power transmitted at the next time-point (t_1) to maximum permitted/possible power output (MAX_MS_PWR) when the anticipated quality value (Z_QQ) is lower than the lowest permitted value, and by increasing the transmission power (MS-PWR) by at least 2dB when the anticipated quality value (Z_QQ) is higher than the lowest permitted value but lower than desired.

6. A method according to Claim 1, **characterized** by estimating the bit error content/bit error frequency during signal transmission at either the base station or the mobile station; and by utilizing said estimated bit error content as a measurement of the signal transmission quality.

7. A method according to any one of the preceding Claims, **characterized** by regulating the transmission power of the mobile station.

8. A method according to any one of Claims 1-6, **characterized** by regulating the transmission power of the base station.

Patentansprüche

1. Verfahren zur Regelung der Leistung (MS_PWR) von übertragenen Funksignalen mit Signalübertragung zwischen einer mobilen Station und einer Basisstation in einem digitalen Mobilfunksystem, worin die Leistungsabgabe (MS_PWR) ständig geregelt wird, so daß die Leistung ausreichend niedrig ist, um nicht unnötigerweise andere Signalübertragungen zu stören, wo eine Übertragung stattfindet, zumindest zeitweise, auf der gleichen Frequenz, aber ausreichend hoch, damit die Signalübertragung ausgeführt wird ohne übermäßigen Informationsverlust aufgrund übermäßig niedriger Signal-/Störungsbedingungen, gekennzeichnet durch die folgenden Schritte:
   - Berechnung eines ersten Signalstärkemittelwerts (MV_1_SS) einer Funksignalübertragung während einer ersten Zeitperiode (A1) von und einschließlich des gegenwärtigen oder augenblicklichen Zeitpunktes (t_0) ab und rückwärts;
   - Berechnung eines zweiten Signalstärkemittelwerts (MV_2_SS) während einer zweiten Zeitperiode (A2) unmittelbar vorhergehend zu der ersten Zeitperiode (A1);
   - Berechnung eines ersten Qualitätsmittelwertes (MV_1_QQ) der Signalübertragung während der ersten Zeitperiode (A1) und eines zweiten Qualitätsmittelwertes (MV_2_QQ) während der zweiten Zeitperiode (A2);
   - Berechnung eines antizipierten Wertes (Z_SS) des Signalniveaus der Signalübertragung zu dem nächsten Zeitpunkt (t_1) basierend auf den Signalstärkemittelwerten (MV_1_SS, MV_2_SS) und einer Übertragungsleistung (MS_PWR), welche unverändert ist im Vergleich mit der Übertragungsleistung (PREV_MS_PWR) zu dem gegenwärtigen Zeitpunkt (t_0);
   - Berechnung eines antizipierten Wertes (Z_QQ) der Qualität der Signalübertragung zu dem nächsten Zeitpunkt (t_1) basierend auf den Qualitätsmittelwerten (MV_1_QQ, MV_2_QQ) und einer Übertragungsleistung (MS_PWR), welche unverändert ist im Vergleich mit der Übertragungsleistung (PREV_MS_PWR) zum gegenwärtigen Zeitpunkt (t_0);
   - Regeln der Übertragungsleistung (MS_PWR) mit Hilfe der antizipierten Werte (Z_SS, Z_QQ) der Übertragungsqualität und des Übertragungssignalniveaus, worin die Übertragungsleistung (MS_PWR) zum nächsten Zeitpunkt (t_1) erhöht wird, wenn die antizipierte Übertragungsqualität (Z_QQ) schlechter ist als ein gewünschter Wert und erniedrigt wird, wenn die antizipierte Qualität (Z_QQ) höher ist als die höchste erlaubte Qualität oder wenn der antizipierte Wert (Z_SS) der Signalstärke größer ist als ein maximal zulässiger Wert (SS_MAX), wobei die Übertragungsleistung (MS_PWR) an-

sonsten unverändert gehalten wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Mittelwertberechnungen ausgeführt werden durch Abtasten der Meßwerte jeweils der Signalstärke (SS) und Signalqualität (QQ) zu konstanten Zeitintervallen, worin die erste Zeitperiode (A1) eine erste Anzahl (SS_A1) von Proben beinhaltet und die zweite Zeitperiode (A2) eine weitere Anzahl von Proben (SS_A2) beinhaltet.

3. Verfahren gemäß Anspruch 2, dadurch gekennzeichnet, daß die erste Anzahl von Proben (SS_A1), die während der späteren Zeitperiode (A1) genommen wurden für jeweils das Signalniveau und die Signalqualität, kleiner ist als die weitere Anzahl von Proben (SS_A2), worin die späteren Proben schwerer gewichtet sind als die früheren Proben.

4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß bei der Berechnung der antizipierten Werte (Z_SS) des Signalniveaus, der zweite Stärkemittelwert (MV_2_SS) addiert wird zu der Differenz zwischen dem ersten (MV_1_SS) und dem zweiten (MV_2_SS) Signalstärkemittelwert multipliziert mit einem Umgebungssignalfaktor (SS_K), und dadurch, daß bei der Berechnung des antizipierten Wertes (Z_QQ) der Signalübertragungsqualität der zweite Qualitätsmittelwert (MV_2_QQ) addiert wird zu der Differenz zwischen dem ersten (MV_1_QQ) und dem zweiten (MV_2_QQ) Qualitätsmittelwert multipliziert mit einem Umgebungsqualitätsfaktor (QQ_K).

5. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die zum nächsten Zeitpunkt (t_1) übertragene Leistung erhöht wird auf die maximal erlaubte/mögliche Leistungsabgabe (MAX_MS_PWR), wenn der antizipierte Qualitätswert (Z_QQ) niedriger ist als der niedrigste zulässige Wert, und daß die Übertragungsleistung (MS_PWR) erhöht wird um mindestens 2 dB, wenn der antizipierte Qualitätswert (Z_QQ) höher ist als der niedrigste zulässige Wert, aber niedriger ist als erwünscht.

6. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Bitfehlergehalt/die Bitfehlerfrequenz während der Signalübertragung abgeschätzt wird entweder an der Basisstation oder an der Mobilstation; und daß der abgeschätzte Bitfehlergehalt verwendet wird als eine Messung der Signalübertragungsqualität.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Übertragungsleistung der mobilen Station geregelt wird.

8. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Übertragungsleistung der Basisstation geregelt wird.

Revendications

1. Un procédé pour réguler la puissance (MS_PWR) de signaux hertziens qui sont émis dans le cadre d'une transmission de signaux entre une station mobile et une station de base dans un système de radiocommunication mobile numérique, dans lequel la puissance d'émission (MS_PWR) est continuellement régulée de façon que cette puissance soit suffisamment faible pour ne pas perturber inutilement d'autres transmissions de signaux lorsque la transmission a lieu, au moins à certains moments, sur la même fréquence, mais suffisamment élevée pour que la transmission de signaux soit effectuée sans perte excessive d'information du fait de conditions correspondant à un rapport signal/perturbation excessivement faible, **caractérisé** par les étapes suivantes :
   - on calcule une première valeur moyenne de niveau de signal (MV_1_SS) d'une transmission de signal hertzien pendant une première période (A1) qui part de l'instant présent (t_0), cet instant étant inclus, et remonte en arrière;
   - on calcule une seconde valeur moyenne de niveau de signal (MV_2_SS) pendant une seconde période (A2) qui précède immédiatement la première période (A1);
   - on calcule une première valeur moyenne de qualité (MV_1_QQ) de la transmission de signal pendant la première période (A1) et une seconde valeur moyenne de qualité (MV_2_QQ) pendant la seconde période (A2):
   - on calcule une valeur prévue (Z_SS) du niveau de signal de la transmission de signal à l'instant suivant (t_1), sur la base des valeurs moyennes de niveau de signal (MV_1_SS, MV_2_SS) et d'une puissance d'émission (MS_PWR) qui est inchangée en comparaison avec la puissance d'émission (PREV_MS_PWR) à l'instant présent (t_0);
   - on calcule une valeur prévue (Z_QQ) de la qualité de la transmission de signal à l'instant suivant (t_1), sur la base des valeurs moyennes de qualité (MV_1_QQ, MV_2_QQ) et d'une puissance d'émission (MS_PWR) qui est inchangée en comparaison avec la puissance d'émission (PREV_MS_PWR) à l'instant présent (t_0);

- on régule la puissance d'émission (MS_PWR) à l'aide des valeurs prévues précitées (Z_SS, Z_QQ) de la qualité de transmission et du niveau de signal, en augmentant la puissance d'émission (MS_PWR) à l'instant suivant (t_1) lorsque la qualité de transmission prévue (Z_QQ) est inférieure à une valeur désirée, et en réduisant la puissance d'émission lorsque la qualité prévue (Z_QQ) est supérieure à la qualité permise maximale ou lorsque la valeur prévue (Z_SS) du niveau de signal est supérieure à une valeur permise maximale (SS_MAX), la puissance d'émission (MS_PWR) étant maintenue inchangée dans les autres cas.

2. Un procédé selon la revendication 1, **caractérisé** en ce que les calculs de valeur moyenne sont accomplis en échantillonnant respectivement les valeurs de mesure de niveau de signal (SS) et de qualité (QQ) à des intervalles de temps constants, dans des conditions dans lesquelles la première période (A1) contient un premier nombre (SS_A1) d'échantillons et la seconde période (A2) contient un autre nombre d'échantillons (SS_A2).

3. Un procédé selon la revendication 2, **caractérisé** en ce que le premier nombre d'échantillons (SS_A1) prélevés pendant la période la plus récente (A1), respectivement pour le niveau de signal et la qualité, est inférieur à l'autre nombre d'échantillons (SS_A2), ce qui fait que les échantillons plus récents sont plus fortement pondérés que les échantillons plus anciens.

4. Un procédé selon la revendication 1, **caractérisé** en ce qu'au moment du calcul des valeurs prévues (Z_SS) du niveau de signal, la seconde valeur moyenne de niveau (MV_2_SS) est additionnée à la différence entre les première (MV_1_SS) et seconde (MV_2_SS) valeurs moyennes de niveau de signal multipliée par un facteur de signal d'environnement (SS_K), et en ce qu'au moment du calcul de la valeur prévue (Z_QQ) de la qualité de transmission de signal, la seconde valeur moyenne de qualité (MV_2_QQ) est additionnée à la différence entre les première (MV_1_QQ) et seconde (MV_2_QQ) valeurs moyennes de qualité multipliée par un facteur de qualité d'environnement (QQ_K).

5. Un procédé selon la revendication 1, **caractérisé** en ce qu'on augmente la puissance émise à l'instant suivant (t_1) jusqu'à la puissance d'émission permise/possible maximale (MAX_MS_PWR) lorsque la valeur de qualité prévue (Z_QQ) est inférieure à la valeur permise la plus faible, et en ce qu'on augmente la puissance d'émission (MS_PWR) d'au moins 2 dB lorsque la valeur de qualité prévue (Z_QQ) est supérieure à la plus faible valeur permise mais inférieure à la valeur désirée.

6. Un procédé selon la revendication 1, **caractérisé** en ce qu'on estime la nature des erreurs de bit/fréquence des erreurs de bit pendant la transmission de signal, à la station de base ou à la station mobile; et on utilise la nature des erreurs de bit estimée à titre de mesure de la qualité de transmission de signal.

7. Un procédé selon l'une quelconque des revendications précédentes, **caractérisé** en ce qu'on régule la puissance d'émission de la station mobile.

8. Un procédé selon l'une quelconque des revendications 1 à 6, **caractérisé** en ce qu'on régule la puissance d'émission de la station de base.

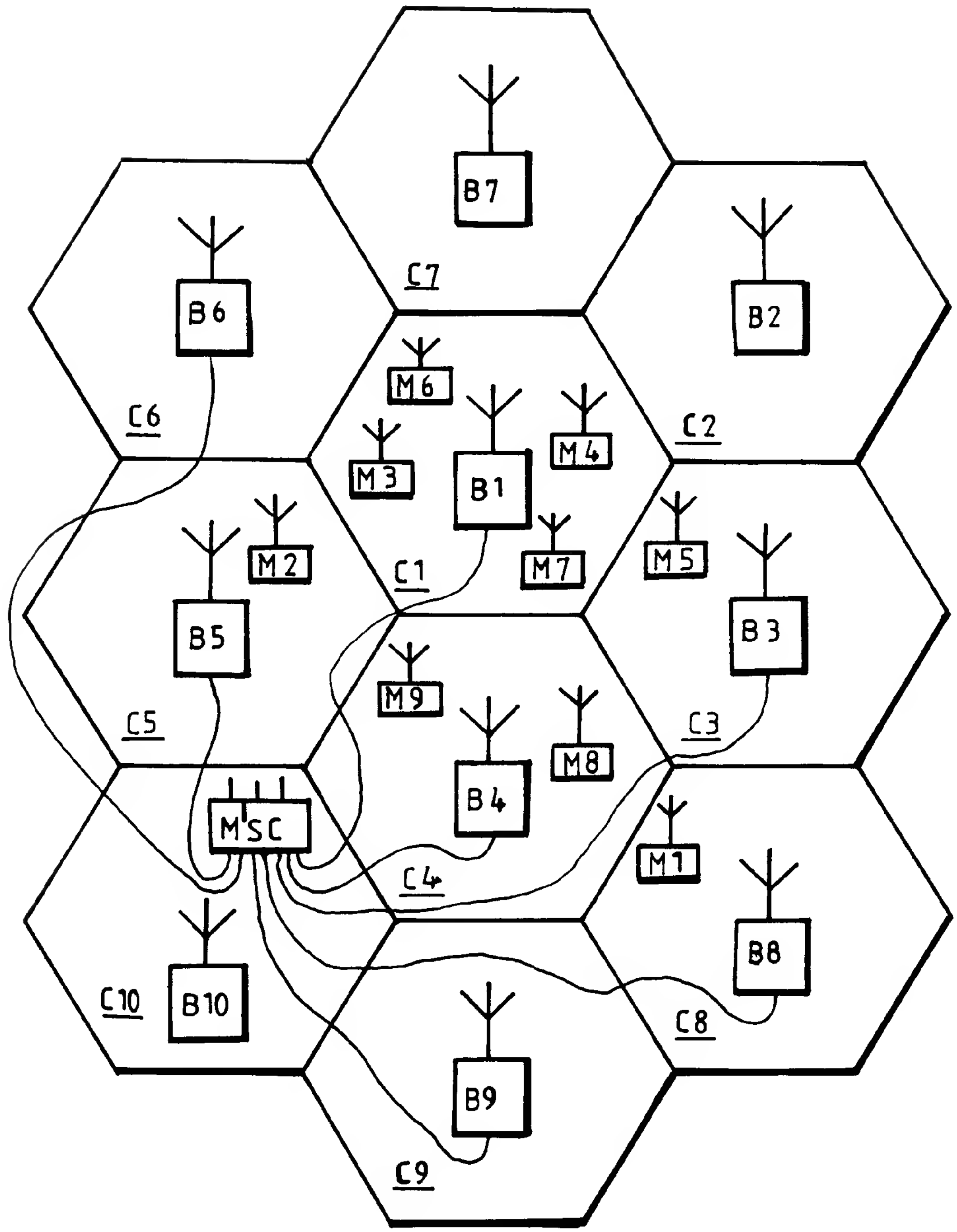
B7
C7
B6
B2
M6
C6
M4
C2
M3
B1
M2
M5
B5
C1
M7
B3
M9
C5
C3
B4
M8
MSC
M1
C4
B8
B10
C10
C8
B9
C9

Fig.1

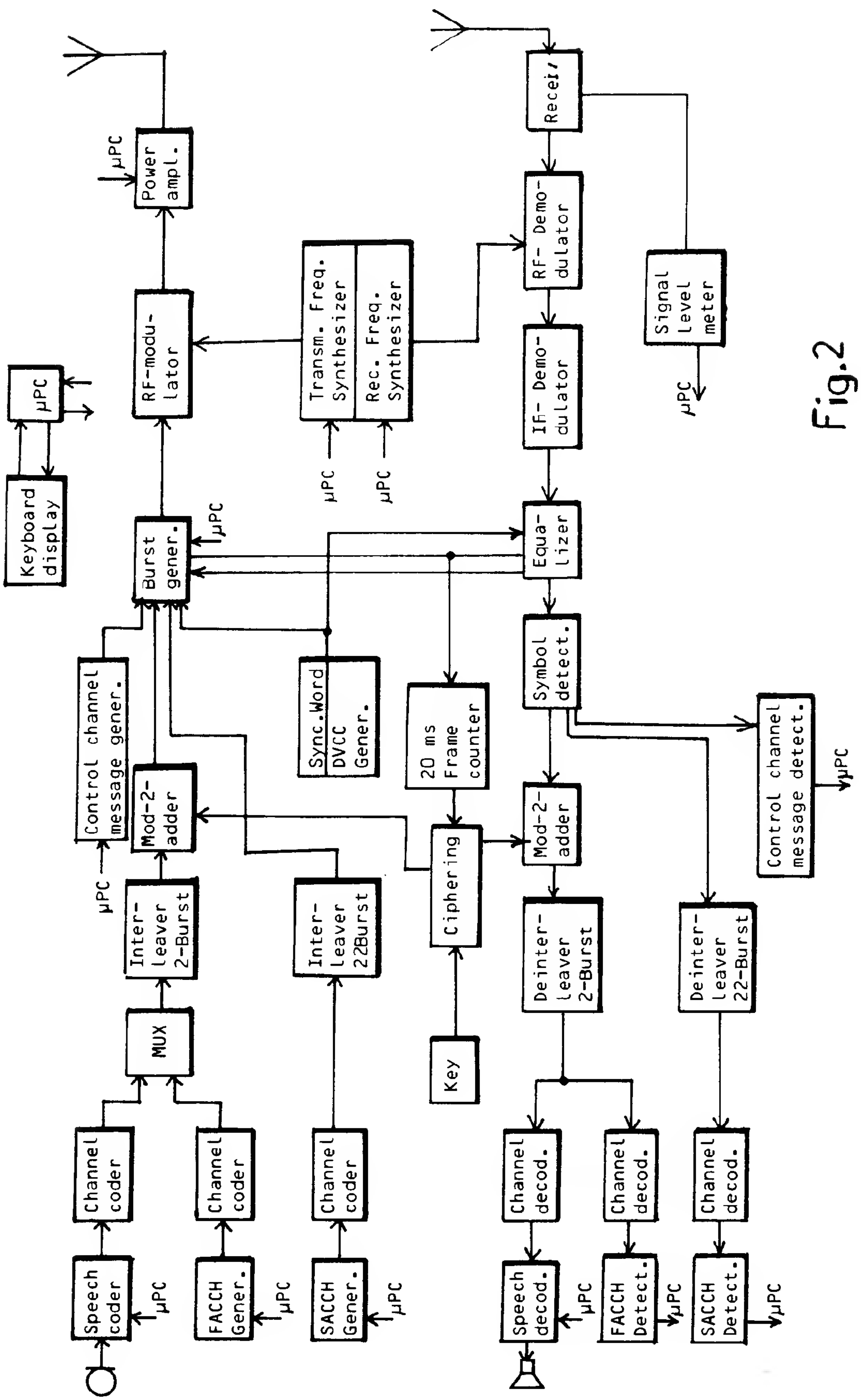
Power ampl.
µPC
RF-modulator
Transm. Freq. Synthesizer
Rec. Freq. Synthesizer
µPC
µPC
µPC
Keyboard display
Burst gener.
µPC
Control channel message gener.
µPC
Mod-2-adder
Inter-leaver 2-Burst
MUX
Channel coder
Channel coder
Speech coder
µPC
FACCH Gener.
µPC
Sync.Word DVCC Gener.
Inter-leaver 22Burst
Channel coder
SACCH Gener.
µPC
20 ms Frame counter
Ciphering
Key
Receiv
RF- Demodulator
IF- Demodulator
Signal level meter
µPC
Equalizer
Symbol detect.
Control channel message detect.
µPC
Mod-2-adder
Deinter-leaver 2-Burst
Deinter-leaver 22-Burst
Channel decod.
Channel decod.
Channel decod.
Speech decod.
µPC
FACCH Detect.
µPC
SACCH Detect.
µPC

Fig.2

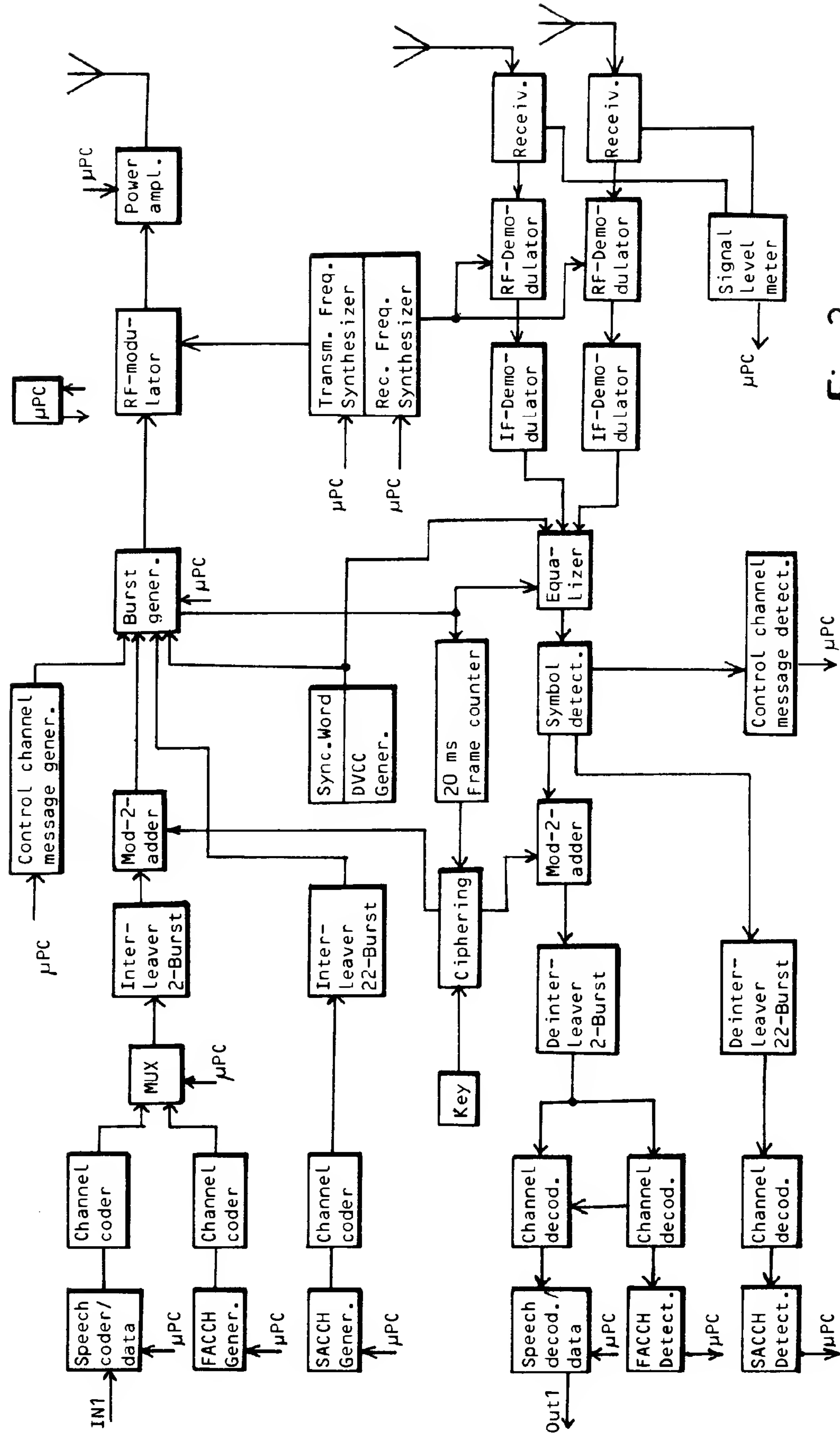
Speech coder/ data
IN1
μPC
Channel coder
FACCH Gener.
μPC
Channel coder
SACCH Gener.
μPC
Channel coder
MUX
μPC
Inter-leaver 2-Burst
Inter-leaver 22-Burst
Mod-2-adder
Control channel message gener.
μPC
Burst gener.
μPC
Sync.Word DVCC Gener.
20 ms Frame counter
Ciphering
Key
μPC
RF-modu-lator
Power ampl.
μPC
Transm. Freq. Synthesizer
Rec. Freq. Synthesizer
μPC
μPC
Receiv.
Receiv.
RF-Demo-dulator
RF-Demo-dulator
IF-Demo-dulator
IF-Demo-dulator
Signal level meter
μPC
Equa-lizer
Symbol detect.
Control channel message detect.
μPC
Mod-2-adder
Deinter-leaver 2-Burst
Deinter-leaver 22-Burst
Channel decod.
Channel decod.
Channel decod.
Speech decod./ data
Out1
μPC
FACCH Detect.
μPC
SACCH Detect.
μPC

Fig. 3

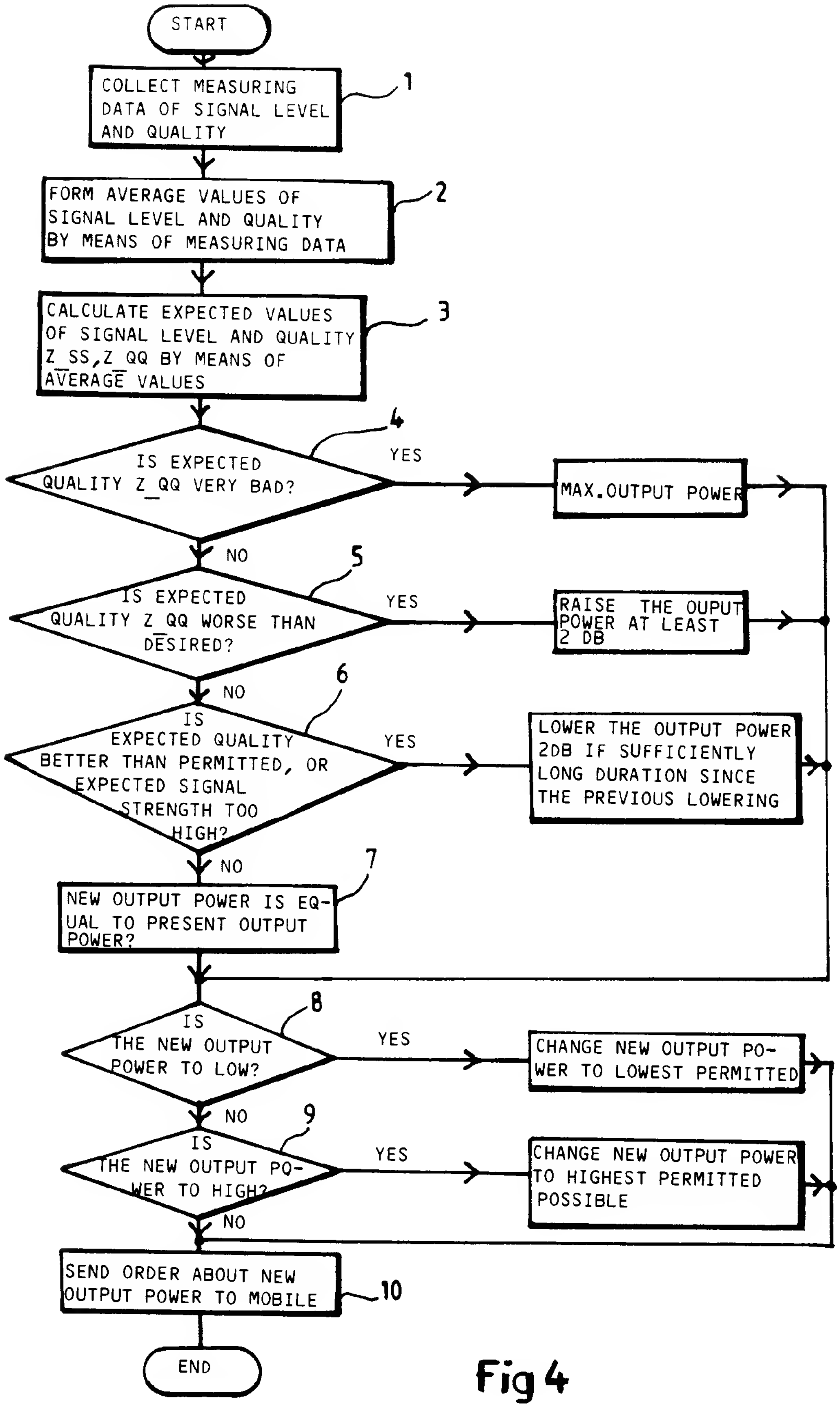
START
COLLECT MEASURING DATA OF SIGNAL LEVEL AND QUALITY
1
FORM AVERAGE VALUES OF SIGNAL LEVEL AND QUALITY BY MEANS OF MEASURING DATA
2
CALCULATE EXPECTED VALUES OF SIGNAL LEVEL AND QUALITY Z_SS,Z_QQ BY MEANS OF AVERAGE VALUES
3
IS EXPECTED QUALITY Z_QQ VERY BAD?
4
YES
MAX.OUTPUT POWER
NO
IS EXPECTED QUALITY Z_QQ WORSE THAN DESIRED?
5
YES
RAISE THE OUPUT POWER AT LEAST 2 DB
NO
IS EXPECTED QUALITY BETTER THAN PERMITTED, OR EXPECTED SIGNAL STRENGTH TOO HIGH?
6
YES
LOWER THE OUTPUT POWER 2DB IF SUFFICIENTLY LONG DURATION SINCE THE PREVIOUS LOWERING
NO
NEW OUTPUT POWER IS EQUAL TO PRESENT OUTPUT POWER?
7
IS THE NEW OUTPUT POWER TO LOW?
8
YES
CHANGE NEW OUTPUT POWER TO LOWEST PERMITTED
NO
IS THE NEW OUTPUT POWER TO HIGH?
9
YES
CHANGE NEW OUTPUT POWER TO HIGHEST PERMITTED POSSIBLE
NO
SEND ORDER ABOUT NEW OUTPUT POWER TO MOBILE
10
END

Fig 4

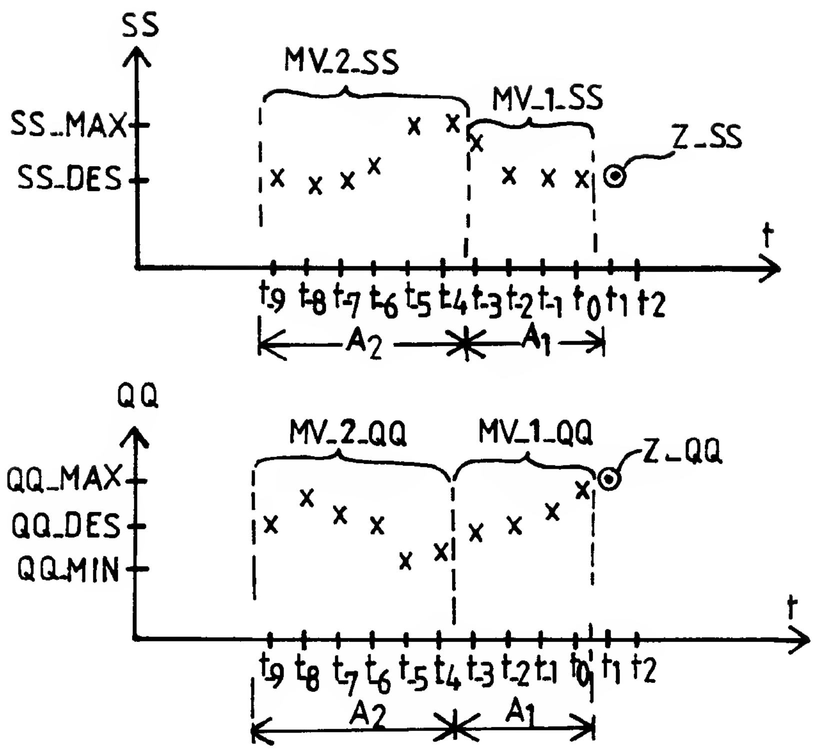
SS
MV_2_SS
MV_1_SS
SS_MAX
SS_DES
Z_SS
t
t9 t8 t7 t6 t5 t4 t-3 t-2 t-1 t0 t1 t2
A2
A1
QQ
MV_2_QQ
MV_1_QQ
Z_QQ
QQ_MAX
QQ_DES
QQ_MIN
t
t9 t8 t7 t6 t5 t4 t3 t2 t1 t0 t1 t2
A2
A1

Fig.5